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Separator for an Axial Actuator

Description

The present invention relates to a separator for axial actuators including two positioner rings comprising at least three pairs of spiral raceways, each movable contrary to the other. Axial actuators/positioners making use of the cited separators find application, for example, in gears, brakes, clutches, differential locks, clamps, presses, and the like.

Known from DE 24 57 886 B1 is a means for relative axial motion of two shaft parts in which a dynamic axial motion is achieved for producing a cyclic axial stroke by a rotating shaft, whereby the axial stroke can be optionally coupled out of engagement. In all example embodiments of this means includes only one rolling element and one or more spiral raceways on only one side part, each of which represents the function of a control cam for determining the timing factor for the stroke. Differingly controlling the relative axial motion of the two shaft parts as described in DE 24 57 886 B1 is achieved in that either the one or the other spiral raceway is employed to permit application of different pitches in each case for various applications. Thus, this known means is not an axial actuator in a strict sense and thus fails to touch upon the problem of reduced friction motion of positioner rings of an axial actuator.

Axial actuators/positioners are used when a rotary motion needs to be converted in a linear motion also in a very restricted space environment and involving high forces. Axial actuators feature spiral raceways facing each other, arranged in the region of a cylindrical shell surface about a longitudinal centerline of the cylinder, i.e. each raceway being actually a wedge „wrapped around" a longitudinal centerline, so-to-speak. Moving the wedges counterwise, i.e. in this case counter-rotating the two positioner rings of the axial actuator, results in each positioner ring being moved relative to the other in being moved towards each other or away from each other in the direction of the longitudinal centerline of the axial actuator. In this arrangement, a small rotation over the wedge surface of the spirals achieves an axial motion which is provided as a stroke or switching motion for one of the

devices as cited above. In one embodiment of an axial actuator having a train of stepped or sawtooth-shaped raceways there is the problem of finding suitable separators permitting communication of the usually very high force associated with axial actuators via the positioner rings with minimum friction.

To reduce the friction between positioner rings of axial actuators a lubricant, for example graphite or a highly viscous grease is used as a rule. Positioner rings are often made also of bronze alloys or the like to ~~ensure~~ certain emergency running properties for „tired" lubricants. Although for best cost-effectiveness it would appear good practice to use pasty, liquid or powdery lubricants, this has the disadvantage that ensuring reliable, safe operation of an axial actuator necessitates complicated regular servicing which, however, in many applications of such axial actuators is practically unfeasible and thus undesirable. This is why means have been sought to permit reliable operational readiness of axial actuators.

It is an objective of the invention to provide a separator for axial actuators comprising a train of spiral raceways which is easy to produce and which greatly reduces the friction between the positioner rings.

This objective is achieved by a separator as set forth in claim 1. The separator in accordance with the invention comprising spirally interconnected spacers, complying with the shape of the raceways, reliable prevent the two positioner rings directly coming into contact with each other. Because the spacers reduce the friction between the positioner rings, the emergency running properties between the positioner rings is substantially better than that of prior art axial actuators. When the separators are made of a friction-reducing material, which is naturally softer than the positioner rings of the axial actuator, they or their contours are able to contact the separator of a friction-reducing material with high pressure in communicating forces with near-zero friction. In one example embodiment of the invention the spiral surfaces are integrally connected to a cylindrical sleeve roughly in the width of the positioner ring raceways. The cylindrical sleeve is guided cylindrically centered by suitable means of the axial actuator. To achieve additional radial guidance of each positioner ring relative to the other, sleeves of the same friction-reducing material as the spacers may be provided at the inner and outer circumferences of the spiral surfaces of the separator in accordance with the invention.

In another advantageous further embodiment of the invention the spacers may be configured like a rolling element cage complying with the same spiral configuration as described above, but comprising rolling element pockets carrying rolling elements protruding beyond the axial definition of the spiral surfaces and which communicate the forces to be handled in operation of the axial actuator axially including rolling friction. Here too, the spacers to be termed spiral cages may be correspondingly located via inner and/or outer radial retaining sleeves. The spacers as described above of a friction-reducing material as well as the spacer decribed thereafter as a spacer cage carrying rolling elements may be configured in a further advantageous embodiment so that each of the spiral surfaces is connected by its upper end to the lower end of the adjoining spiral surface via the step heel inbetween in thus eliminating the need for the sleeves as described above. This may be of advantage in the one or other embodiment.

Further advantages and features of the invention read from the sub-claims. The invention will now be detailled by way of an example with reference to the drawings in which:

Fig. 1 is a greatly diagrammatic axial view of a separator in accordance with the invention.

Fig. 2 is an elevation of the separator as shown in Fig. 1.

Fig. 3 is section taken along the line A-A of the separator as shown in Fig. 1.

Fig. 4 is a greatly simplified diagrammatic view of how two positioner rings are assigned in an axial actuator.

Fig. 5 is an illustration of various example aspects of the separator in accordance with the invention.

Fig. 6 is an illustration of a further example embodiment of a separator in accordance with the invention.

Fig. 7 is a diagrammatic illustration of one example of a separator in accordance with the invention including spacers carrying the rolling elements.

Fig. 8 is an illustration of further example aspects of a separator in accordance with the invention including rolling elements and radially centering

sleeves.

Fig. 9 is an illustration of a further example aspect of the separator in accordance with the invention including a spacer carrying rolling elements.

Referring now to Fig. 1 there is illustrated a separator 2 configured with three spacers 4A, 4B and 4C, each of which in this example aspect features a circular arc of approx. 120°. Diagrammatically depicted in the left-hand lower portion of the spacer 4C are two rolling elements 8 to be detailled later on. Fig. 2 is a side view of the separator 2 as shown in Fig. 1. In this illustration the spiral profile of the spacers 4A, 4B and 4C is particularly clearly evident. Indicated merely by the broken line is a sleeve 6 with which the spacers may be integrally connected. Fig. 3 illustrates the separator 2 as shown in Fig. 1 in a section taken along the line A-A. In this illustration too, the profile of the spacers 4A and 4B about the longitudinal centerline Z is particularly clearly evident. Likewise shown in an example thickness is the sleeve 6 connected to the spacers 4A, 4B and 4C as illustrated by way of example.

The separator 2 as shown in Figs. 1 to 3 is provided for an axial actuator (or positioner) having a train of three spiral raceways. In an axial actuator configured as such no breakaway torque materializes about the longitudinal centerline Z since the positioner rings of the axial actuator are integrally connected with each other in a three-point contact situation as idealized diagrammatically.

Each of the Figs. 4 to 9 as described in the following show a view which would correspond to that as viewing top-down the separator as shown in the plane of the drawing in Fig. 1. Illustrating it in this way has been chosen to simplify its depiction. Fig. 4 is a diagrammatic view of two positioner rings as 10 (upper positioner ring) and 12 (lower positioner ring). Evident between the two positioner rings is an interspace 14 packed with lubricant in prior art, which is likewise configured spiral to conform to the spiral raceways of the axial actuator. Fig. 5 shows spirally configured spacers 4B and 4C arranged to run about the sleeve 6 as already described. Also evident from Fig. 5 is a sleeve 6A depicted by the broken line which may be provided in addition to the sleeve 6 as shown. The plan view on one such sleeve 6A is likewise shown in the illustration of Fig. 1. The height H of the sleeves 6, 6A of the separator 2 as shown in Fig. 5 can be selected as a function of the expedient height of the axial actuator and

is indicated in this case merely by way of example. Fig. 6 shows a further example aspect of a separator in accordance with the invention in which each ~~of the~~ spacers 4A, ~~4B and~~ 4C is connected by its axially „upper" end to the „lower" end of the adjoining spiral surface ~~via~~ so-called heels 4Z. As evident from Fig. 6 there is no need to provide a sleeve 6 or sleeve 6A in such an embodiment.

Fig. 7 shows an embodiment of a separator in accordance with the invention as a kind of roller bearing cage in which rolling elements 8 are inserted in suitable rolling element pockets (not shown). The spacers 14A, 14B, 14C of the aspects of the separators as shown in Figs. 7 to 9 may be made of a friction-reducing material, but not necessarily so. When, however, it is possible that the diameter of the rolling elements arranged in an embodiment of the axial actuator sealed-for-life amounts to or is less than the thickness of the spacer, then it is good practice to make the spacer of a friction-reducing material so that, here too, a certain emergency running property is provided for.

The embodiments as shown in 8 and 9 correspond in principle to the embodiments as shown in Figs. 5 and 6 except for the difference that the example embodiments as shown in Figs. 8 and 9 include rolling elements 8 which, as also evident from Fig. 1, are arranged in the spacer surfaces.

As already mentioned, the spacers may be made of a friction-reducing material such as a bronze alloy or a particularly suitable plastics or some other material, e.g. metal, non-ferrous metal.